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Inventor(s): ;

Applicant(s): CONTROLOGY TECHN LTD ;

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IPC Classification: G08B19/00 ; H02H7/06 ;

Equivalents:

ABSTRACT:

An engine-alternator set 10 connected to an electrical load is controlled by a system having a facia 20 for displaying alternator (electrical) parameters 21, engine (non-electrical) parameters 22 respectively associated with alternator alarms and engine alarms, and status parameters 23 associated with manually-operable READY/RESET and START/STOP switches 23B, 23A. The control system incorporates preprogrammable logic which is responsive to a START signal to effect programmed start-up of the set 10 and which is responsive to preselected alarm conditions to shutdown the set 10 automatically.

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GB 1278589
GB 868253
GB 857687
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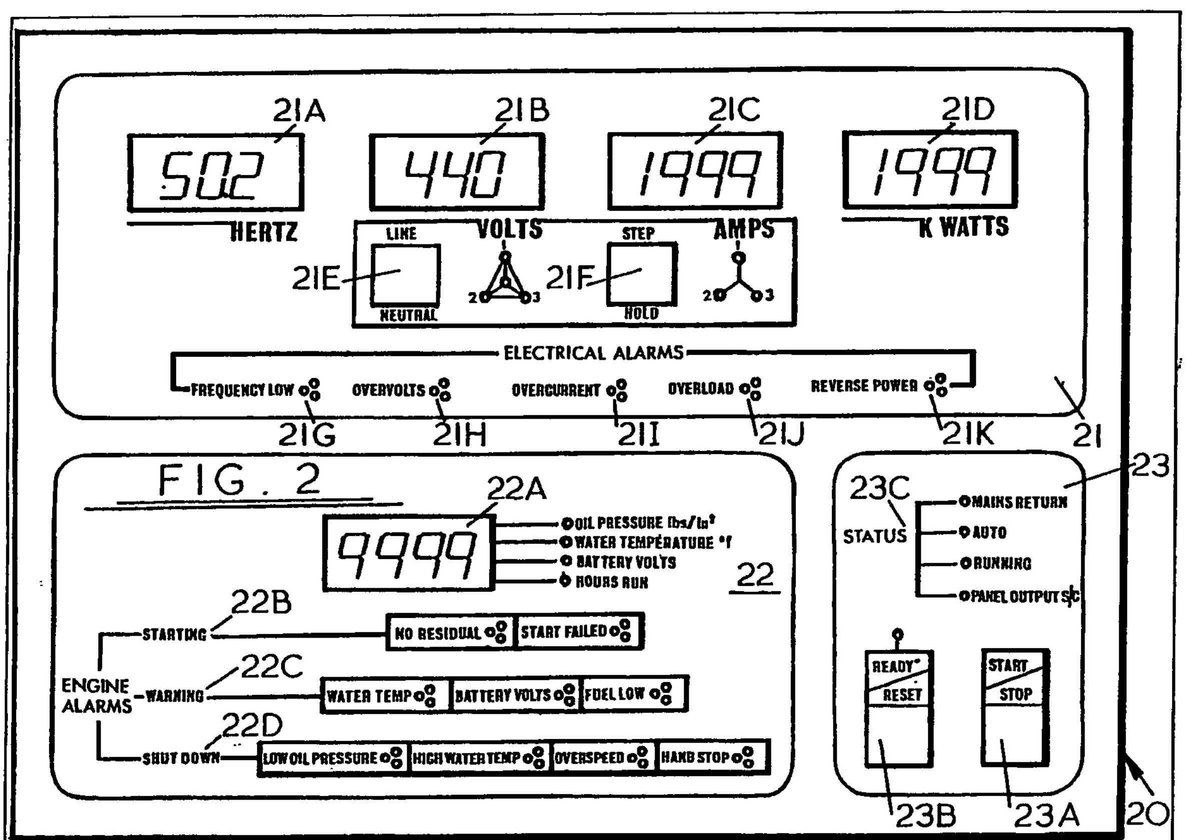
(54) Engine-alternator sets

(57) An engine-alternator set 10 connected to an electrical load is controlled by a system having a facia 20 for displaying alternator (electrical) parameters 21, engine (non-electrical) parameters 22 respectively associated with alternator alarms and engine alarms, and status parameters 23 associated with manually-operable READY/RESET and START/STOP switches 23B, 23A. The control system incorporates pre-programmable logic which is responsive to a START signal to effect programmed start-up of the set 10 and which is responsive to preselected alarm conditions to shut down the set 10 automatically.



The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

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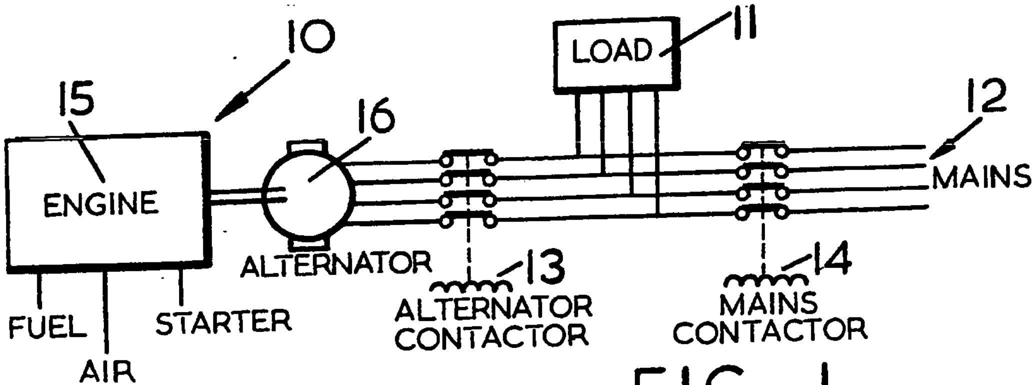

FIG. 1

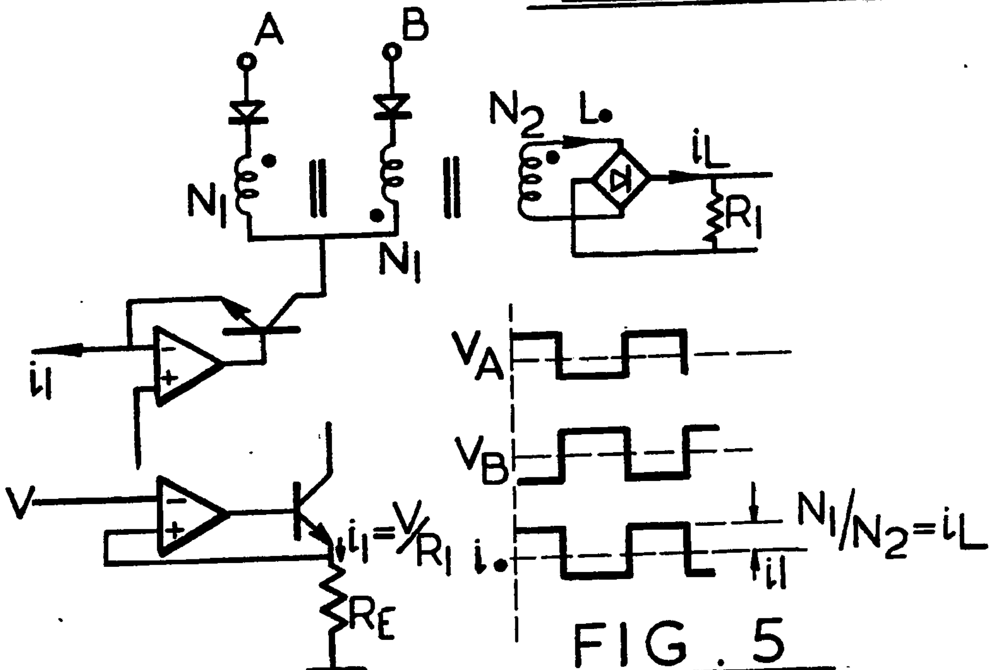

FIG. 5

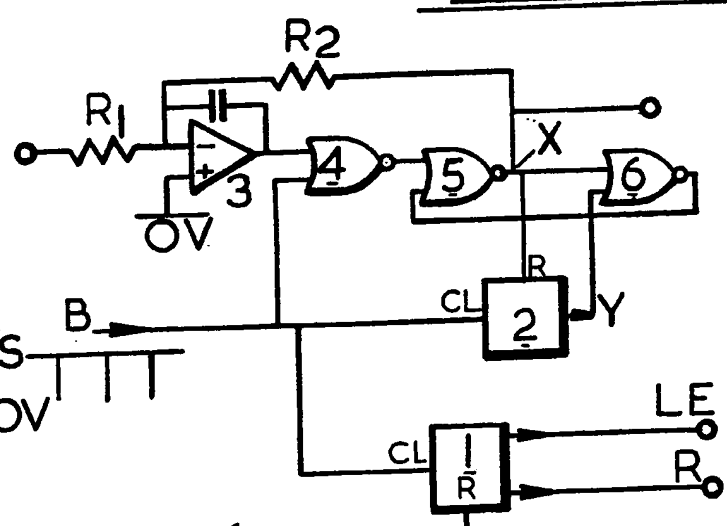

FIG. 6

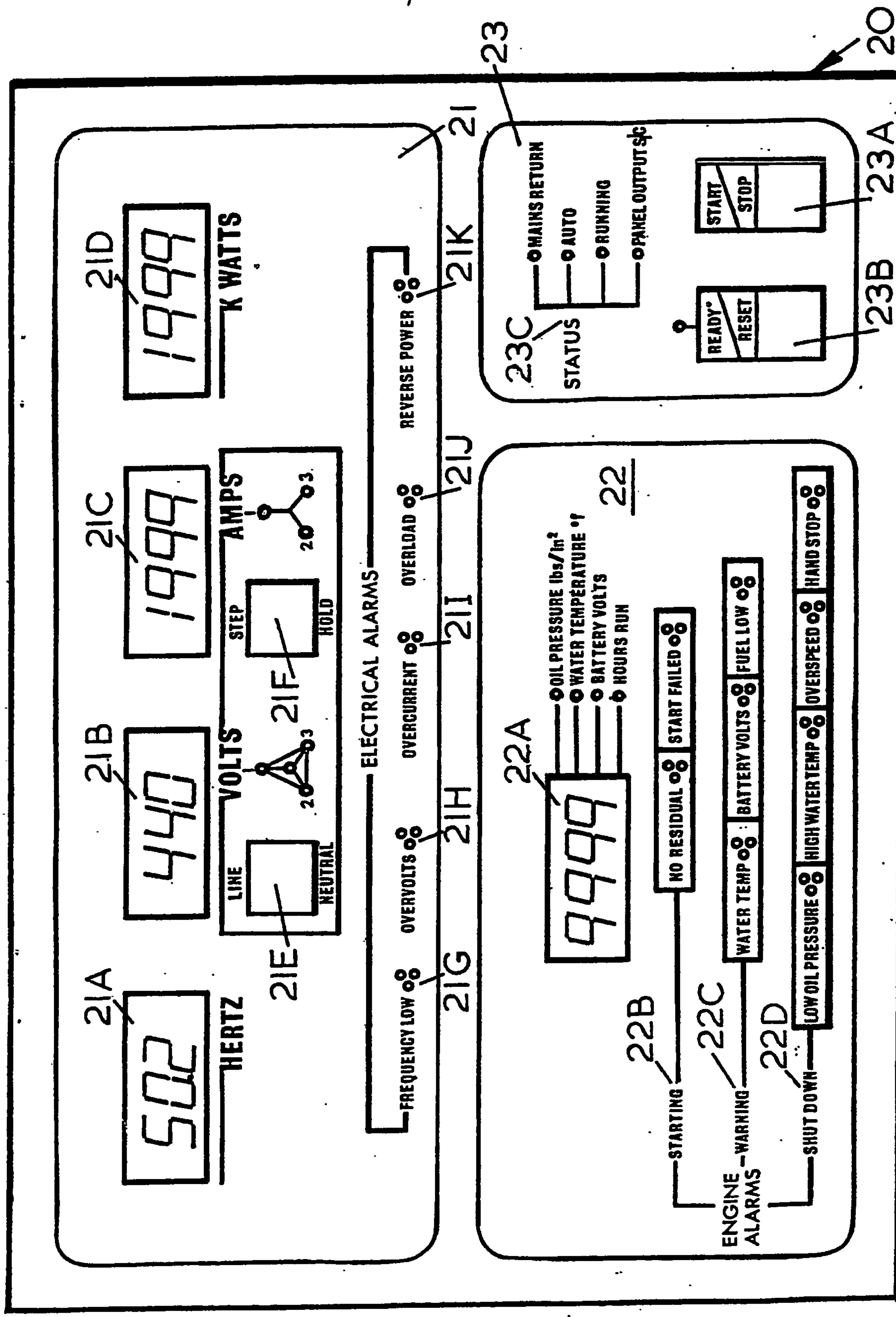
20
21
21A
50.2
HERTZ
21B
440
VOLTS
LINE
NEUTRAL
21C
1999
AMPS
STEP
HOLD
21D
1999
K WATTS
21E
21F
ELECTRICAL ALARMS
FREQUENCY LOW
OVERVOLTS
OVERCURRENT
OVERLOAD
REVERSE POWER
21G
21H
21I
21J
21K
22
22A
9999
OIL PRESSURE lbs/in²
WATER TEMPERATURE °f
BATTERY VOLTS
HOURS RUN
ENGINE ALARMS
STARTING
NO RESIDUAL
START FAILED
WARNING
WATER TEMP
BATTERY VOLTS
FUEL LOW
SHUT DOWN
LOW OIL PRESSURE
HIGH WATER TEMP
OVERSPEED
HAND STOP
22B
22C
22D
23
MAINS RETURN
AUTO
RUNNING
PANEL OUTPUTS
STATUS
23C
START
STOP
23A
READY
RESET
23B

FIG 2

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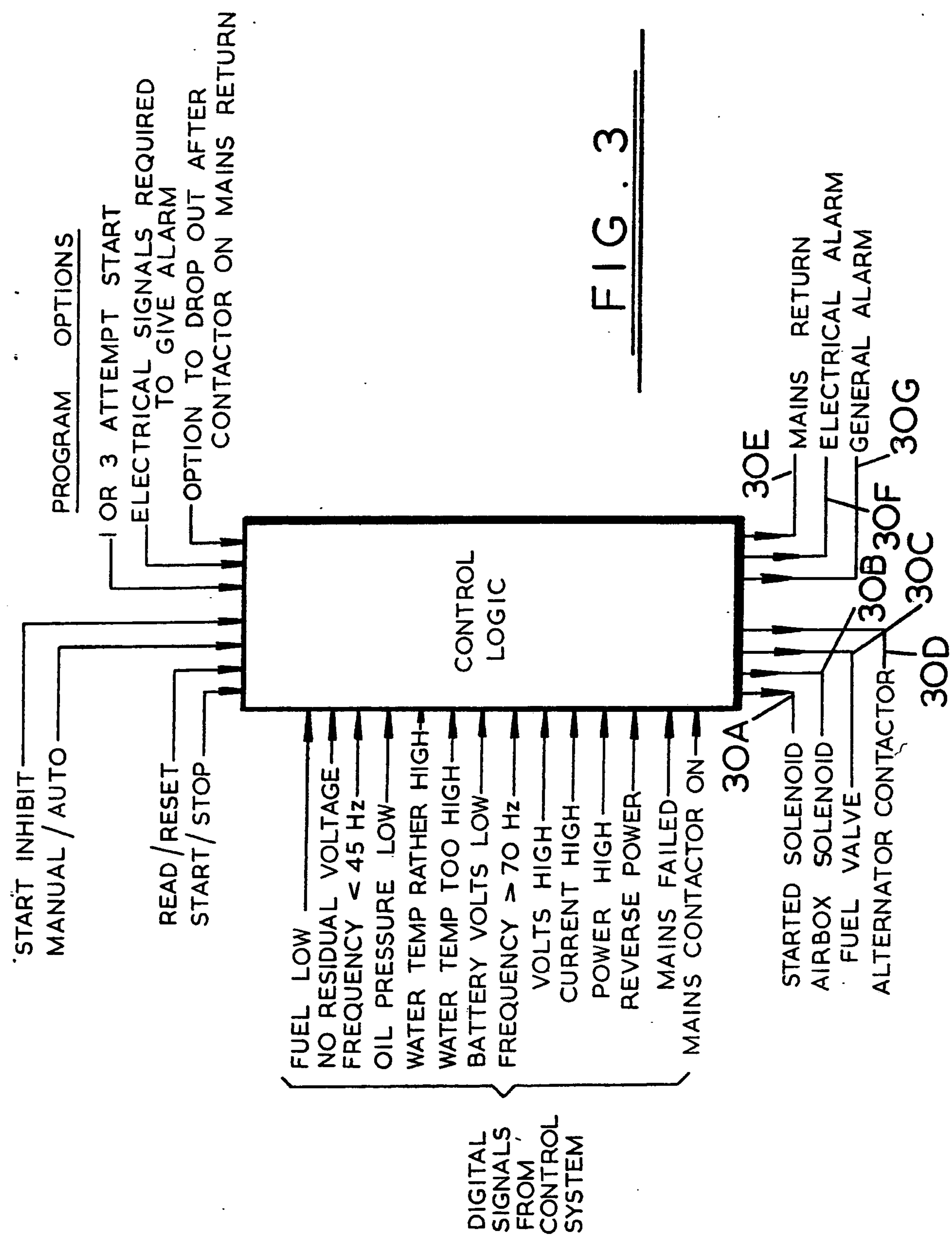

FIG. 3

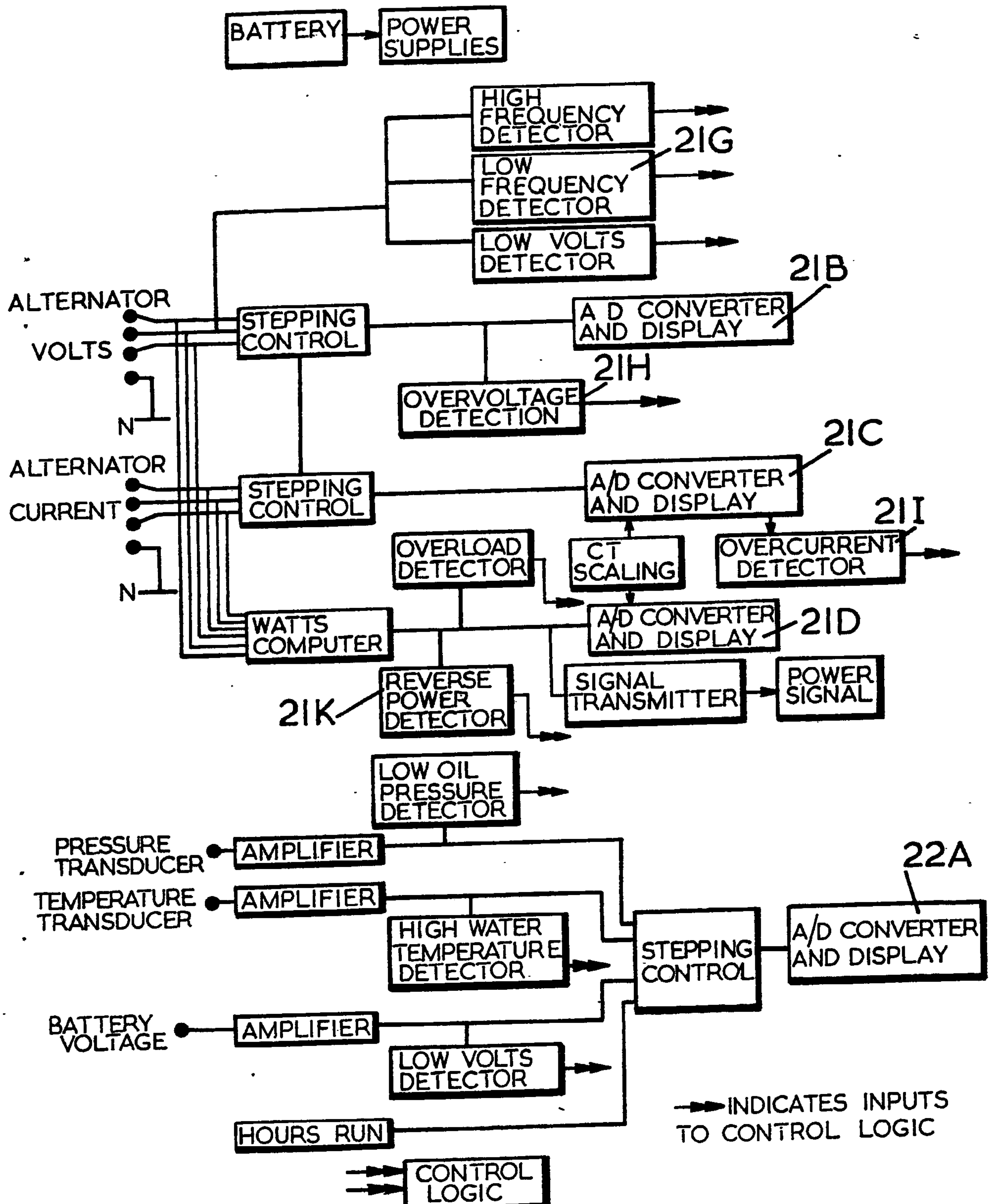
BATTERY
POWER SUPPLIES
HIGH FREQUENCY DETECTOR
21G
LOW FREQUENCY DETECTOR
LOW VOLTS DETECTOR
21B
ALTERNATOR
VOLTS
N
STEPPING CONTROL
A D CONVERTER AND DISPLAY
21H
OVERVOLTAGE DETECTION
21C
ALTERNATOR
CURRENT
N
STEPPING CONTROL
A/D CONVERTER AND DISPLAY
21I
OVERLOAD DETECTOR
CT SCALING
OVERCURRENT DETECTOR
A/D CONVERTER AND DISPLAY
21D
WATTS COMPUTER
REVERSE POWER DETECTOR
21K
SIGNAL TRANSMITTER
POWER SIGNAL
LOW OIL PRESSURE DETECTOR
PRESSURE TRANSDUCER
AMPLIFIER
22A
TEMPERATURE TRANSDUCER
AMPLIFIER
HIGH WATER TEMPERATURE DETECTOR
STEPPING CONTROL
A/D CONVERTER AND DISPLAY
BATTERY VOLTAGE
AMPLIFIER
LOW VOLTS DETECTOR
HOURS RUN
INDICATES INPUTS TO CONTROL LOGIC
CONTROL LOGIC

FIG. 4

SPECIFICATION

Engine-alternator sets

This invention relates to engine-alternator sets and to a control system therefor.

Engine driven alternator sets have a variety of applications. For example they may be used as a source of electrical power where a mains supply is not available, or, where a mains supply is available, they may provide an emergency back-up supply. In any event such sets require to be controlled both during start-up and normal running and the present invention is concerned with a control system which, after initiation, operates automatically to control the functioning of the engine-alternator set.

According to the present invention there is provided a control system for an engine-alternator set comprising means for sensing and displaying the electrical quantities generated by the alternator, means for comparing the sensed quantities with preset values to detect alarm conditions, means for sensing and displaying engine parameters, means for comparing the sensed parameters with preset values to detect alarm conditions, logic means responsive to a start signal to effect starting of the engine-alternator set and responsive to preselected alarm conditions arising to shut down the engine-alternator set automatically.

Preferably the sensed engine parameters are oil pressure, water temperature, and speed; low oil pressure, high water temperature and high speed giving rise to said preselected alarm conditions.

Preferably also the sensed electrical quantities are frequency, voltage, amperage and wattage; low frequency, high voltage, high current, high wattage and reverse wattage giving rise to said preselected alarm conditions.

Said start signal may be manually generated or automatically generated upon detection of a mains failure.

An embodiment of the present invention will now be described by way of example with reference to the accompanying drawings, in which:

Figure 1 shows a typical electrical system incorporating a control system according to the present invention;

Figure 2 illustrates a module of the instrument panel of the control system;

Figure 3 illustrates the control logic of the module of Figure 2;

Figure 4 shows the control system in block diagram form;

Figure 5 illustrates a preferred form of one of the blocks of Figure 4; and

Figure 6 illustrates a preferred form of another block of Figure 4.

Figure 1 of the drawings illustrates a typical application of an engine-alternator set 10 as an emergency stand-by power supply for a load 11 normally supplied by electrical mains 12. The set 10 is connected to the load 11 via an alternator contactor 13 which is normally open and the mains 12 is connected to the load via a mains contactor 14 which is normally closed. The set 10 comprises an engine 15 the output shaft of which drives an alternator 16. The electrical system is 3-phase and neutral.

The control system for the set 10 comprises a module which can be fitted as required to an instrument panel, the module facia 20 being shown in Figure 2. Facia 20 displays electrical parameters as a group 21, engine parameters as a group 22, and status parameters as a group 23.

Group 21 includes frequency, voltage, amperage and wattage meters 21A, 21B, 21C, 21D respectively with a selector switch 21E for selecting either line-to-line voltages or line-to-neutral voltages and a further selector switch 21F for selecting step or hold of the displays on meters 21B and 21C. Additionally group 21 includes visual alarms for low frequency, overvoltage, overcurrent, power overload and reverse power 21G, 21H, 21I, 21J and 21K respectively.

Group 22 includes meter 22A for display of engine oil pressure, engine water temperature, battery voltage, and accumulated hours run, with engine alarms sub-grouped (a) for starting (22B) viz. "no residual" meaning alternator voltage below 2V after 2 seconds with the starter engaged; "start failed" meaning starting sequences completed without alternator frequency reaching a preset frequency, say 34 Hz, (b) for warning (22C) viz. "water temperature" meaning high water temperature, "battery voltage" meaning low battery voltage, and "fuel low" meaning inadequate fuel supplies, and (c) for shut down (22D) viz. "low oil pressure", "high water temperature", "overspeed" meaning frequency greater than a preset value, say 70 Hz and "hand stop" meaning that the start/stop button has been operated during operation of the set 10.

Group 23 includes the start/stop button 23A, a ready/reset button 23B and visual status checks 23C viz. "mains return" which indicates return of the mains voltage when the alternator is running, "auto" which indicates selection of automatic start rather than manual start, "running" which indicates that the alternator is running, and 'panel output s/c' which indicates an overload of the electronics of the control system.

The parameters of group 21 are taken from the alternator output by conventional sensors, the sensed analogue signals being converted to digital signals for the purpose of metering. The frequency meter has a nominal range of 50-60 Hz with a maximum of 75 Hz and an accuracy of ±0.1 Hz. The low frequency alarm setting is typically 34 Hz and is non-operational until after successful start up. The voltage meter has a nominal range of either 110-125 or 220-250V between phase and neutral and a metering accuracy of ±1% F.S.D. ±1 digit (RMS scaled average). Overvoltage alarm setting may be 130, 140, 150 or 260, 280, 300V. The current meter has a nominal range of 0-5A (at the CT secondary) with a maximum of 10A and a metering accuracy of ±1% F.S.D. ±1 digit (RMS scaled average). The overcurrent alarm is set at 5A (at the CT secondary) for each phase. The watt meter has an accuracy of 1% F.S.D. ±1 digit and the power overload is 3 × 120 × CT rating if 130, 140 or 150 overvoltage is selected and 3 × 240 × CT rating if 260, 280 or 300

overvoltage is selected. The reverse power alarm setting is 5% of the power overload alarm.

The parameters of group 22 which are displayed on meter 22A are taken from the engine by conventional sensors (transducers). The low oil pressure alarm may be set at 10, 20, 30 or 40 psi, the warning water temperature alarm at 205°F and the shut-down water alarm at 210°F. The battery voltage may be in the range 8-40V, metered with an accuracy of ±0.3V and the low battery voltage alarm may be set at 11V for a nominal 12V battery, 22V for a 24V battery, or 29.3V for a 32V battery.

The various settings above mentioned are programmed on screwdriver-adjustable switches which are accessible at the rear of the module where all input connections to the module are made. As will be appreciated the control system module is multipurpose and requires to be preset to suit a particular engine alternator set 10. Additionally, the module includes control logic 30 (Figure 3) which controls the operation of the module and various alternative operational procedures are available from the control logic and these require to be preset or preselected. These are:

1 or 3 attempt start
Duration of each start attempt
Delay between each start attempt (3 attempt start)
Delay between mains failure and automatic set starting
Delay between mains return and alternator-contactor drop-out
Delay between successful start and closure of alternator-contactor

If single start is selected the starter on time is set in the range 8-80 seconds in steps of 8 seconds. If triple start is selected the starter on time is selected as for the single start and the off-time is set in the range 4-40 seconds in steps of 4 seconds. A successful start is determined by alternator frequency exceeding the preset value (typically 34 Hz) whereafter the alternator contactor is closed (provided the mains contactor has dropped out) following a delay in the range 2-20 seconds set in steps of 2 seconds. The delay between mains contactor return and alternator contactor drop-out is set in the range 0.2-2.0 hrs in steps of 6 minutes.

As shown in Figure 3 the control logic 30 outputs signal 30A to the engine starter solenoid, 30B to the engine air intake solenoid, 30C to the engine fuel valve, 30D to the alternator contactor, 30E to the mains return indicator at 23C, 30F to the electrical alarms 21G-21K, and 30G to the engine alarms 22B, C and D. The inputs to the control logic 30 are provided by the various programme options, the operator's control buttons 23A, 23B together with master control buttons for manual/auto selection and start inhibit to be described later together with the previously described sensor signals.

In the manual mode the logic 30 operates as follows:

Actuation of ready/reset button 23B energises the power supply for the control system usually for a duration of 15 seconds during which time start-up can be initiated by actuation of the start/stop button 23A. Thus the output signals 30A-30C cause starting of the engine 15 according to the preselected programme option. After a successful start the starter solenoid signal 30A is disabled and signal 30D enabled in order to close the alternator contactor 13. The alternator is shut down by further actuation of the button 23A which disables signals 30B, C and D and after a 15 second time delay the power supply for the control system is disabled.

In the automatic mode actuation of ready/reset button 23B or detection of mains failure causes energisation of the power supply for the control system and the start-up procedure is undertaken automatically thereafter following a preset time delay in the range 2-20 seconds set in steps of 2 seconds. Following return of the mains supply the alternator contactor signal 30D is disabled and the alternator shut down automatically thereafter following a 30 second delay period.

In either the manual or automatic mode the operation of the set 10 is dependent upon the absence of an engine shut-down alarm as indicated on the module facia (Figure 2). Should any one of these alarms come into operation the set 10 is automatically shut down by logic 30. The alarm fault then remains in a latched condition and prevents a restart attempt until the ready/reset button 23B is actuated. Because the electrical alarms 21G-21K are not very critical not all of these alarms need to operate in a latching manner but those which are set to do so are combined in the electrical alarm signal 30F which inhibits a restart attempt until reset by button 23B.

The control system may also be operated to monitor the electrical parameters on the load side of the alternator contactor 13 by actuation of a master start inhibit switch. In this mode of operation the set 10 is inhibited from starting but the control system power supply is energised to permit metering of the electrical parameters.

Figure 4 is a simplified block diagram of the control system from which it will be evident that the battery used for restarting the engine 15 also energises the power supplies which in turn energise the remaining electrical components of the system. All parameters are measured in analogue fashion and are converted to digital for display and control purposes. It will be noted that prior to display of voltage and current stepping controls are provided. These controls are arranged to step repeatedly around the monitored electrical parameters so that, for example in the case of current the metered value is that of phase A, then phase B, then phase C, then phase A again, and so on. However, by actuation of switch 21F (Figure 2) the stepping controls can be held on one metered value, e.g. the current of phase B, and stepping is inhibited. The stepping control prior to the voltage display 21B can be switched by switch 21E (Figure 2) to monitor either line-to-line voltages or line-to-neutral voltages. These stepping controls are preferably of the kind described in our U.K. Patent Specification No. 2057148A utilizing RCA type CD 4019 AND/OR select gates.

For the purpose of providing a remote indication of power generated the d.c. analogue output of a wattage computer is fed to a signal transmitter. This

transmitter takes the form shown in Figure 5 which is fed with antiphase square wave voltages A,B whose amplitudes need not be well controlled. These square waves are each fed through a diode and CT coil of N_1 turns to the collector of a common transistor the base current of which is provided by an operational amplifier. In one arrangement the emitter current of the transistor is forced by the action of the operational amplifier to the value of the input signal i_1. Consequently the transistor collector current is substantially equal to i_1 also and this current is drawn alternately from square waves A and B according to the polarity thereof. The driving mmf in the CT is therefore always proportional to i_1 but its direction changes at the frequency of the waves A and B because of the winding arrangements of the CT coils. The CT has an output coil of N_2 turns which feeds through a full wave rectifier to a load resistor R_1 providing a current i_L therein. If the CT has sufficiently high inductance it can be shown that

$$i_L = i_1 \cdot N_1/N_2$$

For improved accuracy the error introduced by the transistor base current can be reduced or eliminated by use of a Darlington connected transistor pair (or triple) or an FET transistor. Alternatively, a second differential amplifier can be used to sense the actual transistor collector current, the output of this second differential amplifier then being level shifted to provide a differential voltage for the basic differential amplifier. A further alternative is to sense i_1 via a further CT coil in the CT secondary circuit since the current i_o through the secondary circuit is proportional to the CT mmf as is i_1. In this case the output of the further CT coil would require to be rectified.

Figure 6 illustrates a form of analogue-to-digital converter that may be used on receipt of an analogue signal to be displayed provided by a conventional stepping controller. The analogue input signal (which is negative) is at terminal A of Figure 6 while the counter and display is supplied from terminal C and is controlled by an enabling signal LE and a reset signal R both supplied by a counter the only input of which is a clock signal of period P at terminal B. The counter is set with a count number N and generates a N×P time interval between reset signal R rising and enabling signal LE rising.

A NOR latch is provided by NOR gates 5 and 6 coupled to a second counter whose output Y is at logic 0 (0 volts) if its input R is at logic 1 (+ V Volts) and when R falls to logic 0 output Y rises to logic 1 M×P later. The output × of gate 5 is fed back to the input of integrator 3 through a small value resistor R_2 so that if × is at logic 1 the integrator output Ƶ falls. When Ƶ reduces below the threshold of NOR gate 4 the next clock pulse at terminal B causes the NOR latch to be set so that x becomes logic 0 and this situation remains until output Y of the second counter becomes logic 1. During the time that output X is at logic 0 integrator output Ƶ rises at a rate dependent on how negative the analogue signal A is and resets the NOR latch so that it is again at logic 1. Integrator 3 does not draw any d.c. current component.

It can readily be shown that the number produced in the output counter is proportional to the input analogue voltage V_A, the constant of proportionality comprising $N/_M$ so that either or both of these values can be altered. This can be utilised in the wattmeter or ameter A/D converters of Figure 4 where it is necessary to correlate the digital read-out with the CT ratio used to sense current. For example $N/_M$ can be changed in ratios 2, 2.5, 3....... etc. which are BS standard CT rated primary current values.

CLAIMS

1. A control system for an engine-alternator set comprising means for sensing and displaying the electrical quantities generated by the alternator, means for comparing the sensed quantities with preset values to detect alarm conditions, means for sensing and displaying engine parameters, means for comparing the sensed parameters with preset values to detect alarm conditions, logic means responsive to a start signal to effect starting of the engine-alternator set and responsive to pre-selected alarm conditions arising to shut down the engine-alternator set automatically.

2. A control sysem as claimed in claim 1, wherein the sensed engine parameters are oil pressure, water temperature, and speed; low oil pressure, high water temperature and high speed giving rise to said preselected alarm conditions.

3. A control system as claimed in claim 1 or claim 2, wherein the sensed electrical quantities are frequency, voltage, amperage and wattage; low frequency, high voltage, high current, high wattage and reverse wattage giving rise to said preselected alarm conditions.

4. A control system as claimed in any preceding claim, wherein a regulated power supply which is fed from the engine battery and said logic means is effective to start the engine after a time delay following said start signal during which said regulated power supply becomes stabilised.

5. A control system as claimed in any preceding claim, wherein said logic means forms part of a module incorporating optional programmes and presettable means are provided in the module to control said logic means to follow one of said optional programmes.

6. A control system as claimed in claim 5, wherein said optional programmes include single or multi attempt engine start; duration of starter on time; duration of interstart delay in the multi start option.

7. A control system as claimed in claim 1 and substantially as hereinbefore described with reference to the accompanying drawings.

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